Pergamon

J. Quant. Spectrosc. Radiat. Transfer Vol. 52, No. 6, pp. 887–896, 1994

0022-4073(94)00082-4

0022-4073/94 $7.00 + 0.00

EXPERIMENTAL DETERMINATION OF THE STARK PARAMETERS OF PbI, PbII, AND CuII SPECTRAL LINES IN A PLASMA OF THE PULSE CAPILLARY DISCHARGE

I. S. FISHMAN, E. V. SARANDAEV, and M. KH. SALAKHOV†

Department of Physics, Kazan State University, 420008 Kazan, Tatarstan, Russia

(Received 16 December 1993)

Abstract—This paper demonstrates the feasibility of using an impulsive capillary light-source for measuring the Stark parameters of atomic and ionic spectral lines. The diagnostics of this source have been carried out. The electron density has been measured using the H_α line ($N_e = 10^{18}\,\mathrm{cm}^{-3}$), the temperature by the method of relative intensities of copper ionic lines and the source function ($T = 2.4 \cdot 10^4$ K). The Stark parameters of a number of lines of lead and copper atoms and ions have been determined from non-self-absorbed spectral lines. Our results are compared with the data in available literature.

1. INTRODUCTION

The Stark parameters of the spectral lines of neutral atoms and ions (electron half-width ω_{oe}, electron shift d_{oe}, and ionic broadening parameter α_o for a given electron density), have been the subject of numerous experimental and theoretical investigations.[1-9] The knowledge of the Stark broadening parameters of spectral lines is vital in astrophysics and plasma physics and permits one not only to determine plasma properties but also to test the existing broadening theories. Theoretical calculations of the profiles, widths, shifts, and ionic broadening parameters of a number of lines of light-weight elements upto Ca and of Cs have been carried out in Refs. 1 and 2. Comparison of the values obtained in a semi-classical approximation with the available experimental data showed good agreement within 20%.[4-8] However, the situation is different with heavy elements. Theoretical calculations and experimental investigations have been rather limited, and the discrepancy between theoretical estimates and experiment is much larger than for the lighter elements. Thus, for CdI and HgI the difference is 5–7 fold,[10] with experimental results being as a rule higher than theoretical ones. For PbI atomic lines the experimental results exceed the theoretical ones by a factor of 2.5[11] and suggests that the discrepancy is largely caused by experimental errors.[10] A shock tube with an electron density of 10^{16}–$10^{17}\,\mathrm{cm}^{-3}$ was used as a light-source in Ref. 11. However, at the above electron density the profile width is not large enough, whereas the other kinds of non-Stark broadening may not be negligible and taking them into account is normally difficult, which results in considerable errors. One may judge the magnitude of non-Stark broadening by, among others, Bach's work,[12] using a shock tube. In the total width of 0.63 Å of the line profile of Al I the contribution of the Van-der-Waals component alone is estimated by the author[12] to be 0.18 Å. Other kinds of non-Stark broadening also contribute. It follows from the above discussion that there is an urgent need for elaboration and perfection of experimental techniques for measuring the Stark parameters.

A capillary impulse discharge was used as a light-source, which permitted us to increase the electron density by an order of magnitude and, thereby, the line width. In addition, this light-source makes it possible to simplify the technique of supplying a substance to the discharge zone. We have also devised an original method of recording both the emission spectrum across the light-source and the hydrogen spectrum during a single impulse.

†To whom all correspondence should be addressed.